REMARKS

Claims 1-17 were pending in the present application. No claims have been amended, added, or canceled. Therefore, claims 1-17 are pending. Applicant respectfully requests reconsideration and withdrawal of the claim rejections for the reasons that follow.

Formal Drawings

Applicant sincerely thanks Examiner Stock for approving the proposed drawing corrections submitted on March 20, 2003 and April 15, 2003. Applicant respectfully submits that formal drawings were submitted with the proposed drawing changes on April 15, 2003. Applicant requests that the Examiner use the formal drawings submitted previously. However, if these cannot be located, copies of the formal drawings (and corresponding Transmittal) are attached.

Claim Rejections Under 35 U.S.C. § 103(a)

In the Office Action, claims 1, 3, and 6-9 were rejected under 35 U.S.C. §103 as being unpatentable over U.S. Patent No. 5,982,483 to Lauinger et al. (hereinafter "Lauinger") in view of U.S. Patent No. 6,433,873 to Chen (hereinafter "Chen") and U.S. Patent No. 4,823,185 to Miyamoto et al. (hereinafter "Miyamoto"). Claim 2 was rejected under 35 U.S.C. §103(a) as being unpatentable over Lauinger in view of Chen and Miyamoto as applied to claim 1, and further in view of U.S. Patent No. 4,634,248 to Ostermeier (hereinafter "Ostermeier"). Claims 4 and 5 were rejected under 35 U.S.C. §103(a) as being unpatentable over Lauinger in view of Chen and Miyamoto as applied to claim 1, and further in view of U.S. Patent No. 5,914,749 to Bawolek et al. (hereinafter "Bawolek"). Claims 10, 14, 15, and 17 are rejected under 35 U.S.C. §103(a) as being unpatentable over Lauinger in view of Chen and Miyamoto as applied to claim 1, and further in view of U.S. Patent No. 4,965,663 to Sasaki (hereinafter "Sasaki"). Claims 11-13 and 16 were rejected under 35 U.S.C. §103(a) as being unpatentable over Lauinger in view of Chen, Miyamoto, and Sasaki as applied to claim 10, and further in view of U.S. Patent No. 6,411,746 to Chamberlain et al. (hereinafter "Chamberlain"). Applicant respectfully traverses these rejections for at least the following reasons.

In the present Office Action, the PTO has simply replaced the Tomioka reference (U.S. Patent No. 5,088,816) from the previous Office Action (dated December 20, 2002) with a combination of Chen and Miyamoto. However, as prior art references, Chen and Miyamoto are no better than the Tomioka reference. Therefore, the arguments presented in Applicant's March 20, 2003 reply will be re-iterated, as they apply to Chen and Miyamoto.

With respect to independent claim 1, a *prima facie* case of obviousness has not been established. In particular, the Lauinger/Chen/Miyamoto combination does not teach or suggest the claimed structure of the grating optical sensor, namely the required "at least one light-diffusion plate arranged in either a pupillary plane of the lens or a pupillary plane conjugate to the lens or both." Applicant agrees with the patent office that Lauinger is silent with respect to these features. Further, neither Chen nor Miyamoto teaches, suggests, or discloses the claimed arrangement of a light diffusion plate in either a pupillary plane of the lens or a plane conjugate to the lens.

The features of the claimed diffusion plate are explained in the specification, such as paragraphs 0022-0023. The diffusion plate is arranged in either a pupillary plane of the lens imaging the object space or in a pupillary plane conjugate to the lens because this location in the optical system provides for color constancy performance of a grating optical sensor adaptable to variable illumination.

By way of background, it is known that "the image that will be formed in a photographic camera, i.e. the distribution of intensity on the sensitive layer, is present in an invisible, mysterious way in the aperture of the lens, where the intensity is equal at all points." (F. Zernike, Proc.Phys.Soc. London 61, (1948), p. 158).

By way of further background, the distribution of intensity in the image plane represents the local information about each point in the object space. However, the intensity within the aperture (the pupillary plane) represents the global information about the overall illumination of the object space. As claimed, the placement of a light diffusion plate in the pupillary plane (and/or a plane conjugate to the pupillary plane) scatters uniformly the global information into the image plane. This claimed structure results in an intensity of local images which automatically form the ratio of local to global intensity in the object space.

In contrast, Chen is silent with respect to this claimed feature. Chen discloses placing a diffuser 90 between the entrance pupil 30 and the photodetective plane 40 to mitigate the effect caused by non-uniform color distribution. (See, e.g., Fig. 6 and col. 2, lines 40-45.) As suggested by this disclosure, the diffuser 90 is arbitrarily placed between

the entrance pupil 30 and the photodetective plane 40. Chen does not teach, suggest, or disclose at least one light-diffusion plate arranged in either a pupillary plane of the lens or a plane conjugate to the lens.

On page 3 of the Office Action, the PTO states that Chen "teaches using a diffuser in a conjugate papillary [sic] plane...". It appears that the PTO is confusing "conjugate" with "adjacent" or "parallel" or the like. In sharp contrast, conjugate points (or planes) are defined as points (or planes) that are physically related to each other with respect to a lens or lens system according to standard optics equations. "...[C]onjugate planes... are images of each other... If points P and P' are conjugate points, then all the rays that start at P must end up at P'." (M. V. Klein and T. E. Furtak, *Optics*, Wiley and Sons, New York (1986), p. 154-155.) Further, "planes through these [conjugate] points perpendicular to the [optical] axis are called <u>conjugate planes</u>." (F. A. Jenkins and H. E. White, *Fundamentals of Optics*, Mc-Graw Hill, New York (1957), p. 32). For example, consider an object that is imaged using a convex lens. A point on the object and the corresponding point on its image are <u>conjugate</u> points. Chen does not specifically locate the diffuser 90 with respect to the entrance pupil 30 and the photodetective plane 40, and therefore does not teach, suggest, or disclose at least one light-diffusion plate arranged in either a pupillary plane of the lens or a plane <u>conjugate</u> to the lens. Unlike the present invention, a diffuser 90 arbitrarily located between the entrance pupil 30 and the photodetective plane 40 simply is not capable of <u>uniformly</u> scattering the global information into the image plane. To satisfy claim 1 of the present application, the light-diffusion plate must be arranged in either the pupillary plane of the lens or a pupillary plane conjugate to the lens or both.

None of the cited references (Lauinger, Miyamoto, Ostermeier, Bawolek, Sasaki, and Chamberlain) cures the deficiencies of Chen. Therefore, independent claim 1, and all claims dependent therefrom, are believed to be patentable over the cited references. Withdrawal of the rejections is respectfully requested.

Method claims 15-17 contain similar limitations and are believed to be patentable over the cited references for at least the same reasons. Withdrawal of the rejections is respectfully requested.

Further, method claims 15-17 are patentable over the cited references for the following additional reasons, as restated from Applicant's March 20, 2003 reply.

The cited combination does not teach or suggest "<u>forming a white standard signal from the diffraction pattern</u>, assigned to a colorless part of the object space, with identical chromatically additive brightness values and a maximum trichromatically additive brightness

value," as recited in independent claim 15. In contrast, the method disclosed by Sasaki is based on the densitometric measurement of three stimulus values R, G, B from the light reflected from the sample. In addition, three stimulus values Ro, Go, Bo are determined from a standard color, such as white. The standard values and the individual values are combined according to a mathematical algorithm.

The method in the present application does not claim use of a white standard as such but a special method for "forming" such a white standard signal, where the white standard signal is directly formed from chromatically additive brightness values and a maximum trichromatically additive brightness value assigned to a selected RGB diffraction pattern in the image plane.

For at least the reasons stated above, Applicant respectfully submits that the pending claims are allowable.

Response to Examiner's Comments (Office Action p. 8)

The Examiner states that, in arguing against prior art, "one cannot show nonobviousness by attacking references individually where the rejections are based on combinations." Applicant respectfully points out that, at the very least, the combination of the prior art references must teach or suggest <u>every</u> claim limitation to establish a *prima facie* case of obviousness. MPEP 2143. Thus, because <u>none</u> of the cited references teaches, suggests, or discloses at least one light-diffusion plate arranged in either a pupillary plane of the lens or a pupillary plane conjugate to the lens or both, as recited in claim 1, the inquiry into nonobviousness ends before it begins.

Conclusion

Applicant believes that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested.

The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

Respectfully submitted,

Date 9/5/03

By [signature]

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OPTICS

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$$\det \mathbf{R} = 1 \tag{3.46a}$$

$$\det \mathbf{T} = 1 \tag{3.46b}$$

$$\det \mathbf{M} = 1 \tag{3.46c}$$

4. Conjugate Planes. The system matrices that we have been discussing were derived with the idea that the rays in question need to be identified at the refracting interfaces within the system. The formalism is more general than that. We can employ the translation matrix to move our reference planes away from the optical interfaces. This is particularly important when considering *conjugate planes.* These are *images of each other.* In Fig. 3.20, P and P' are *conjugate points.* The geometry and refracting characteristics of the overall optical setup are contained within the transformation matrix. The details of this matrix will be revealed later. For now, let us just identify the optical influence of the shaded region as contained in matrix $\tilde{\mathbf{M}}$. We use here the tilde notation over the matrix to indicate that the matrix connects conjugate planes.

The general transformation takes on the form

$$\begin{pmatrix} n'\alpha' \\ x' \end{pmatrix} = \begin{pmatrix} \tilde{M}_{11} & \tilde{M}_{12} \\ \tilde{M}_{21} & \tilde{M}_{22} \end{pmatrix} \begin{pmatrix} n\alpha \\ x \end{pmatrix}$$

from which we can identify the role of each of the terms of the system matrix.

$$n'\alpha' = \tilde{M}_{11} n\alpha + \tilde{M}_{12} x$$

or

$$\alpha' = \left[\tilde{M}_{11}\left(\frac{n}{n'}\right)\right]\alpha + \left[\frac{\tilde{M}_{12}}{n'}\right]x \tag{3.47}$$

and

$$x' = [\tilde{M}_{21} n]\alpha + [\tilde{M}_{22}]x \tag{3.48}$$

If P and P' are conjugate points, then all the rays that start at P must end up at

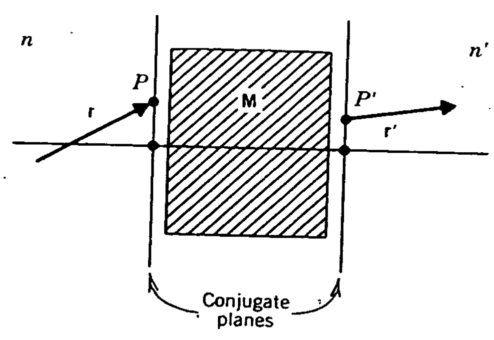

Fig. 3.20 Conjugate planes connected by system matrix **M**.

P'. This means that, in Eq. (3.48), x' must be independent of the angle of the original ray, α. This condition is met if

$$\tilde{M}_{21} = 0 \tag{3.49}$$

Then $x' = \tilde{M}_{22}x$, and we can define the *lateral magnification*

$$m_x \equiv \frac{x'}{x} = \tilde{M}_{22} \tag{3.50}$$

as the linear scale factor between points on the conjugate planes.

Let us also define a ray-angular magnification as

$$m_\alpha \equiv \frac{\Delta\alpha'}{\Delta\alpha} \tag{3.51}$$

Then from Eq. (3.47) we can see that

$$m_\alpha = \tilde{M}_{11}\left(\frac{n}{n'}\right) \tag{3.52}$$

The overall transformation matrix between conjugate planes now becomes

$$\tilde{\mathbf{M}} = \begin{pmatrix} m_\alpha \dfrac{n'}{n} & \tilde{M}_{12} \\ 0 & m_x \end{pmatrix} \tag{3.53}$$

This must still satisfy Eq. (3.46c), thus

$$m_x m_\alpha \frac{n'}{n} = 1 \tag{3.54'}$$

When written in terms of the components of the rays this becomes

$$nx\,\Delta\alpha = n'x'\,\Delta\alpha' \tag{3.54}$$

These equations should be recognized as the Lagrange equations that were first presented in Eq. (3.31) for a single refracting surface.

B. Single Lens

1. General Formulation. A lens consists of two refracting surfaces in series. Fig. 3.19 is a prototypical example. In the class of lenses we will consider, the interfaces are spherical sections. However, aspheric lenses can be built for specialized purposes (such as focusing a monochromatic laser beam). In the paraxial limit, we can use the matrix formalism to describe the behavior of a general ray that passes through both surfaces of the lens. Fig. 3.21 shows the annotated model system. The intercepts of the front and rear surfaces of the lens with the optical axis are at the vertices V and V', respectively. The indices of refraction need not be the same on either side of the lens, and the thickness D_ℓ in the general case, need not be small.

FUNDAMENTALS OF OPTICS

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object point Q are shown refracted by a concave spherical surface separating the two media of index $n = 1.0$ and $n' = 1.50$, respectively. The focal lengths have the ratio 1:1.50.

Since the refracted rays are diverging, they will not come to a focus at any point. To an observer's eye located at the right, however, such rays will appear to be coming from the common point Q'. In other words, Q' is the image point corresponding to the object point Q. Similarly M' is the image point corresponding to the object point M. Since the refracted rays do not come from Q' but only appear to do so, no image can be formed on a screen placed at M'. For this reason such an image is said to be *virtual*.

3.4. Conjugate Points and Planes. The principle of the reversibility of light rays has the consequence that, if $Q'M'$ in Fig. 3D were an object, an image would be formed at QM. Hence, if any object is placed at the position previously occupied by its image, it will be imaged at the position previously occupied by the object. The object and image are thus interchangeable, or conjugate. Any pair of object and image points such as M and M' in Fig. 3D are called *conjugate points*, and planes through these points perpendicular to the axis are called *conjugate planes*.

If one is given the radius of curvature r of a spherical surface separating two media of index n and n', respectively, as well as the position of an object, there are three general methods that may be employed to determine the position and size of the image. One is by graphical methods, a second is by experiment, and the third is by calculation using the formula

$$\frac{n}{s} + \frac{n'}{s'} = \frac{n' - n}{r} \qquad (3b)$$

In this equation s is the object distance and s' is the image distance. This equation, called the Gaussian formula for a single spherical surface, is derived in Sec. 3.10.

Example: The end of a solid glass rod of index 1.50 is ground and polished to a hemispherical surface of radius 1 cm. A small object is placed in air on the axis 4 cm to the left of the vertex. Find the position of the image. Assume $n = 1.00$ for air.

Solution: By direct substitution of the given quantities in Eq. 3b we obtain

$$\frac{1}{4} + \frac{1.50}{s'} = \frac{1.50 - 1.00}{1} \qquad \frac{1.50}{s'} = \frac{0.50}{1} - \frac{1}{4}$$

from which $s' = 6.0$ cm. One concludes, therefore, that a real image is formed in the glass rod 6 cm to the right of the vertex.

As an object M is brought closer to the primary focal point, Eq. 3b shows that the distance of the image from the vertex, AM', becomes